UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2017/18
Subject (*)	Theory of Vibration		Code	730G03040
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optativa	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Industrial			
Coordinador	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Lecturers	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Web	https://sites.google.com/site/structuralanalysislab/home			
General description	This course is intended for the acquisition of the specific skills to analyze the behavior of structures and mechanical elements under vibrations and to design these elements under dynamic loads			

Study programme competences	
Code	Study programme competences
A1	Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álxebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización.
A2	Comprensión e dominio dos conceptos básicos sobre as leis xerais da mecánica, termodinámica, campos e ondas e electromagnetismo e a súa aplicación para a resolución de problemas propios da enxeñaría.
A13	Coñecemento dos principios de teoría de máquinas e mecanismos.
A23	Coñecementos e capacidades para aplicar os fundamentos da elasticidade e resistencia de materiais ao comportamento de sólidos reais.
B2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
B3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía
B6	Ser capaz de concibir, deseñar ou poñer en práctica e adoptar un proceso substancial de investigación con rigor científico para resolver calquera problema formulado, así como de comunicar as súas conclusións ?e os coñecementos e razóns últimas que as sustentan? a un público tanto especializados como leigo dun xeito claro e sen ambigüidades
B7	Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
B9	Adquirir unha formación metodolóxica que garanta o desenvolvemento de proxectos de investigación (de carácter cuantitativo e/ou cualitativo) cunha finalidade estratéxica e que contribúan a situarnos na vangarda do coñecemento
C1	Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C2	Desenvolverse para o exercicio dunha cidadanía aberta, culta, crítica, comprometida, democrática e solidaria, capaz de analizar a realidade, diagnosticar problemas, formular e implantar solucións baseadas no coñecemento e orientadas ao ben común.
C3	Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras.
C4	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C5	Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.
C6	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes

Learning outcomes	Study programme competences		
Handle the principles of vibration theory to analyze dynamic systems: response under free and forced vibration to single degrees of freedom SDOF and multiple degrees of freedom MDOF systems, harmonic load, and general type excitations.	A1 A2 A13 A23	B2 B5 B9	C1 C3 C5
Knowledge about the standards which govern the design and analysis of elastic solids and structures under dynamic loads. Knowledge and application of the main techniques of mathematical modeling for dynamic analysis.	A1 A2 A13 A23	B2 B3 B6 B9	C2 C4 C6
Apply properly theoretical concepts not laboratory. Understand and apply some technical computing solution: numerical methods for the analysis of vibrating systems.	A1	B3 B6 B9	C2 C4 C6
Solve exercises and problems of vibrations in a complete and reasoned way through current tools: use of a commercial finite element program.	A1 A2 A13 A23	B3 B6 B7	C1 C2 C3 C4 C5 C6
Use a rigorous language in the engineering structural dynamics in order to show and to explain information and results		B2 B3 B5 B6 B7 B9	C1 C2 C3 C4 C5 C6

Contents	
Topic	Sub-topic
Chapter 0. The following topics develop the contents set up in the verification memory.	Dynamic equations. Modelling. Vibration of systems of 1 and N degrees of freedom. Buffer. Vibration of continuous systems
Chapter 1. Introduction to structural dynamics:dynamic equations and modeling.	Basic concepts. Classification of vibrations. Modelling systems: stiffness, inertia, and damping elements. Mathematical models of Single Degree Of Freedom (SDOF) systems. Application of Newton's laws. Application of the principle of virtual displacements. Hamilton principle. Application of the Lagrange equations.
Chapter 2. Free vibration of SDOF system. Damping.	Free vibration of undamped SDOF systems. Free vibration of viscous damped SDOF systems. Other types of damping.
Chapter 3. Response of SDOF to harmonic excitation. Damping.	Response of undamped SDOF to harmonic excitation. Response of viscous damped SDOF to harmonic excitation. Complex frequency response. Vibration isolation. Force Transmissibility. Base motion. Response of SDOF due to unbalance in rotating machines.
Chapter 4. Analytical methods of solution. Response of SDOF to a general dynamic excitation	Response of SDOF to special forms of excitation. Ideal step input, rectangular pulse and ramp loadings. Short-duration impulse. Unit impulse response. Classification of methods. Duhamel Integral Method.
Chapter 5. Numerical methods of solution. Response of SDOF to a general excitation.	Numerical evaluation of the integral of convolution. Method of linear forces. Step by step methods. The average acceleration method. Methods of Newmark family.
Chapter 6. Continuous systems. Mathematical models of Multiple Degrees Of Freedom (MDOF) systems	Continuous systems. Discrete systems: application of Newton's laws, application of the Lagrange equations. Equations of motion.

Chapter 7. Free vibration response of MDOF systems	Natural frequencies and modes of vibration of MDOF systems. Free vibration response of MDOF systems. Rigid body modes of vibration. Some properties of the natural frequencies and natural modes. Scaling or normalizing. Orthogonality. Expansion theorem. Free vibration response of MDOF systems. Mode-superposition method.
Chapter 8. Forced vibration response of MDOF systems.	Mode-superposition method response of undamped MDOF systems. Truncation. Damped MDOF systems. Orthogonal, modal, classic or proportional damping. Rayleigh damping. Non-proportional damping.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Laboratory practice	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	10	20	30
Seminar	A13 A23 B2 B3 B5 B6 B7 B9 C2 C3 C4 C6	8	14	22
Supervised projects	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	14	42	56
Objective test	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9	2	6	8
Guest lecture / keynote speech	A2 A13 A23 B2 B3 B5 B6 B7 B9 C1 C2 C4 C6	8	24	32
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Laboratory practice	Methodology that allows the realization of activities of practical character, with computer, such as modelization, analysis and dynamic simulation of mechanical and structural elements.
Seminar	Technique of work in group to resolve practical cases, by means of exhibition, discussion, participation and calculation. A calculator is employed
Supervised projects	Methodology designed to promote autonomous learning of students, solving a problem that involves the contents of the course and involves specific skills, under teacher supervision.
Objective test	A rigorously developed instrument for measuring the knowledge, abilities and skills developed in the subject
Guest lecture / keynote speech	Oral lecture supplemented with the use of audiovisual means, aiming transmit knowledge and facilitate the learning within the scope of vibration analysis

Personalized attention	
Methodologies	Description
Seminar Laboratory practice Supervised projects	Guidance and revision about specific problems posed at the development of the different activities proposed in the course. Revision and help when making supervised projects.

Assessment			
Methodologies	Competencies	Description	**Qualification**

Objective test	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9	Theoretical and practical questions on the subject, individual realization, with limited time, that allow the monitoring of the learning process	20
Laboratory practice	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	Students must systematically attend practices. The proposed activities have to be done along the practical sessions, in order to be revised and evaluated by the teacher. The practices that aren?t developed during the practical classes, and periodically revised by the teacher will not be considered in the qualification. The evaluation process of the laboratory lessons includes a two hour practice session, where the student solves with the computer the problems proposed by the teacher, individually.	10
Supervised projects	A1 A2 A13 A23 B2 B3 B5 B6 B7 B9 C1 C2 C3 C4 C5 C6	The projects include the theoretical and practical contents of the course. They are to be done individually. The projects will be developed during the practical sessions along the course and completed at home on the student personal work hours. The tasks will be followed and revised during the practical lessons. If the projects aren?t matured during the practical classes, nor periodically revised by the teacher, will not be considered in the qualification.	70

Assessment comments
The student, whose face-to-face work throughout the four-month period is not sufficient for evaluation, will be able to perform an objective test which allow evaluation and qualification.

Sources of information	
Basic	- R. Gutiérrez, E. Bayo, A. Loureiro y L.E. Romera (2009). Teoría de Estructuras III. Servicio de publicaciones de la Universidade da Coruña - R. R. Craig (1981). Structural Dynamics. John Wiley and Sons, Inc - S.S. Rao (2012). Vibraciones Mecánicas.Quinta Edición. Pearson Education, México. - Dassault Systèmes Simulia Corp. (2011). Abaqus Analysis User?s Manual. Providence, RI, USA. (1998)
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Diferential Equations/730G03011 Strength of Materials/730G03013 Theory of Machines/730G03019 Theory of Structures /730G03021 Strength of Materials II/730G03027 Mechanics/730G03026
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.